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Operating at peak current levels 10(13) times greater than previously attempetd, channeling radiation photon fluxes of 10(19) photons/sr-keV-sec over a picosecond duration at a wavelength of 0.42 angstrom wer observed. The experimental efforts wer hamperd by the shutdown of John Madey's storage ring accelerator at Stanford. However the experiments located at the Naval Postgraduate School, the Sakatchewan Accelerator Laboratory and the Institute for Atomic Physics at Darmstaadt (Germany). Thusfar, four publications and one PhD thesis have resulted directly from this work.

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Final Report

Contract No. AF-F49620-86-K-0015

Object: To investigate the generation of radiation from channeled particles.

This project was intended to coordinate with the construction of John Madey's linear accelerator and positron storage ring. On the Mark III linac we assembled a channeling radiation beamline which included a goniometer, focussing and steering magnets, vacuum pumps, TV cameras, and retractable screens for e-beam viewing.

The primary purpose of the experiments on the linac were to demonstrate that channeling radiation can be an inexpensive source of bright, hard x-rays with picosecond duration. Channeled particle trajectories are similar to the trajectories in a magnetic wiggler, but the equivalent magnetic field would have to be about ten megagauss. Indeed, we measured[1] a photon flux of 10^{19} photons/sr-keV-sec over a picosecond duration at a wavelength of 0.42 Å. Our peak current levels were $\approx 10^{13}$ times greater than the currents used in previous channeling experiments and average currents were $\approx 10^{8}$ times greater.

To perform these measurements we had to develop a spectrometer capable of operating at high photon fluxes with several percent energy resolution at x-ray wavelengths, and in a bremsstrahlung background. This was accomplished using a graphite crystal Bragg reflector, a photomultiplier detector, and specially designed apertures[2].

During the course of this project the Madey accelerator was shut down, but we continued the experimental work on accelerators located at the Naval Postgraduate School in Monterey, at the Saskatchewan Accelerator Laboratory in Saskatoon, Canada, and the accelerator at the Institut für Keruphysik in Darmstaadt, Germany.

Thusfar, four publications have resulted from these efforts [1-4], along with one Ph.D thesis[5]. It is anticipated that there will be one more publication and one more Ph.D. thesis resulting from this project.

In addition to the high power channeling radiation research, we also studied channeling radiation in superlattices, both theoretically, and experimentally at Darmstaadt.

Superlattices offer a means for increasing the radiation, utilizing the periodicity of the layers.

The Madey storage ring was to provide a bright positron current source for seeking x-ray laser action by means of channeling radiation. A current density of 10^7 - 10^8 A/cm^2 could be obtained, which would provide significant stimulated gain over a picosecond time interval. (The time duration is determined by the interval over which the crystal remains intact.) Unfortunately, the storage ring was never constructed so that this portion of the program could not be carried out.

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